Development of a 77K Reverse-Brayton Cryocooler with Multiple Coldheads, Phase I

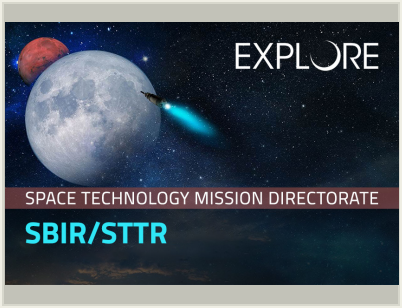
Completed Technology Project (2004 - 2004)

Project Introduction

RTI will design and optimize an 80 W, 77K cryocooler based on the reverse turbo Brayton cycle (RTBC) with four identical coldheads for distributed cooling. Based on preliminary analysis, the single centrifugal compressor with integrated motor will be 10 cm in diameter and 15 cm in length, and rotate at about 100,000 rpm. Each coldhead (consisting of a recuperative heat exchanger, turbo-expander and cold side heat exchanger) is expected to be about 6X6X15 cm in linear dimensions, and weighs about 0.2 kg. Key technical innovations are superior aerodynamics for a compact, reliable and efficient compressor, distributed RTBC cryocooling with a single compressor, and techniques to drastically minimize performance-degrading axial conduction in recuperative heat exchangers. Microfabrication is a key enabler for implementation of this concept. Phase I will involve system design, and design and fabrication of the compressor. The Phase II goal is to integrate the compressor with motor, electronics and gas foil bearings with a target isentropic efficiency of 80% at a pressure ratio of 1.75. It is expected that the coefficient of performance of the overall RTBC system when completed would be at least 0.12, with the minimum and maximum cycle temperature being 64 K and 440 K respectively.

Anticipated Benefits

Potential NASA Commercial Applications: Since commercial and military satellites require cryogens and propellants as well, all of the benefits that the proposed system can offer to NASA applications are also applicable to those non-NASA applications. Further applications include distributed sensor cooling of large military and commercial space systems, cryocooling needed for medical process and equipment such as cryo-surgery and MRI, cooling of superconducting electronics for telecommunication. Compact and light design of the propose system can enable desk-top MRI machines, thus allowing wider access. Superconducting electronics would allow wider range and much improved signal quality for wireless communication devices and cell towers.



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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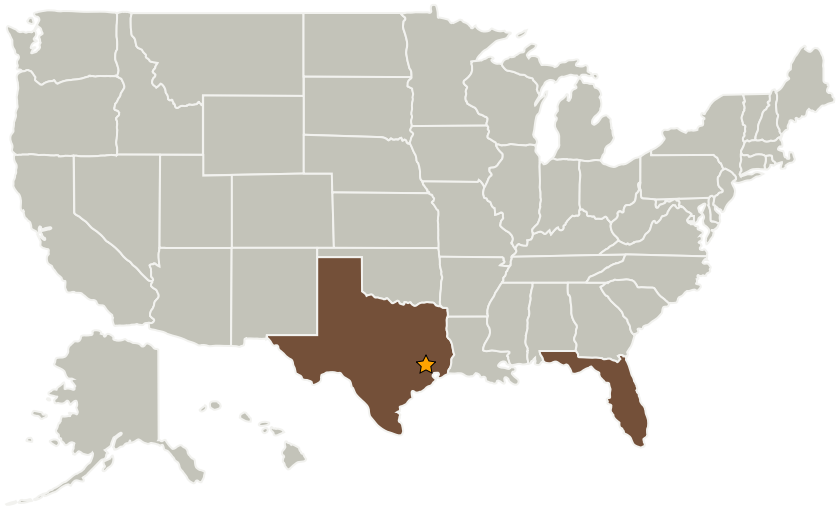
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Rini Technologies, Inc.	Supporting Organization	Industry	Orlando, Florida

Primary U.S. Work Locations	
Florida	Texas

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Daniel Rini

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.3 Thermal Conditioning for Sensors, Instruments, and High Efficiency Electric Motors